Junction: A Decentralized Platform for Ad Hoc Social and Mobile Applications

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Motivation

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- Ad Hoc
  - Bring together devices with no previous contact
- Mobile
  - Leverage the personalized computing power in our pockets
- Social
  - Bring multiple users together for real-time applications

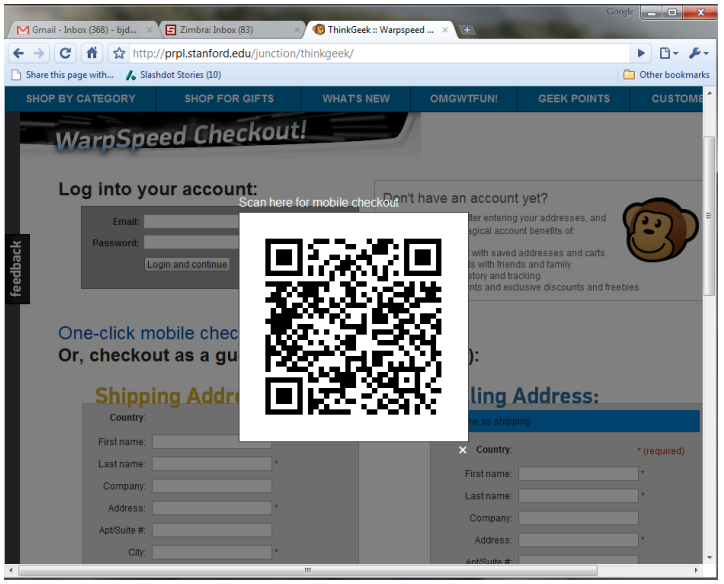
- Requirements of multi-party, ad hoc activities
  - 1. Device discovery
  - 2. Code deployment
  - 3. Communication

Demo: weTube

Ad Hoc Activities

- Multimedia sharing
  - Bring your personality with you (your music, your photos, …)
- Multiplayer games
  - Public / private screens for new types of play
  - No single application server
- Secure web transactions

Consumer-Friendly Secure Web Transactions



Snap2Pass
Challenge-response web auth.

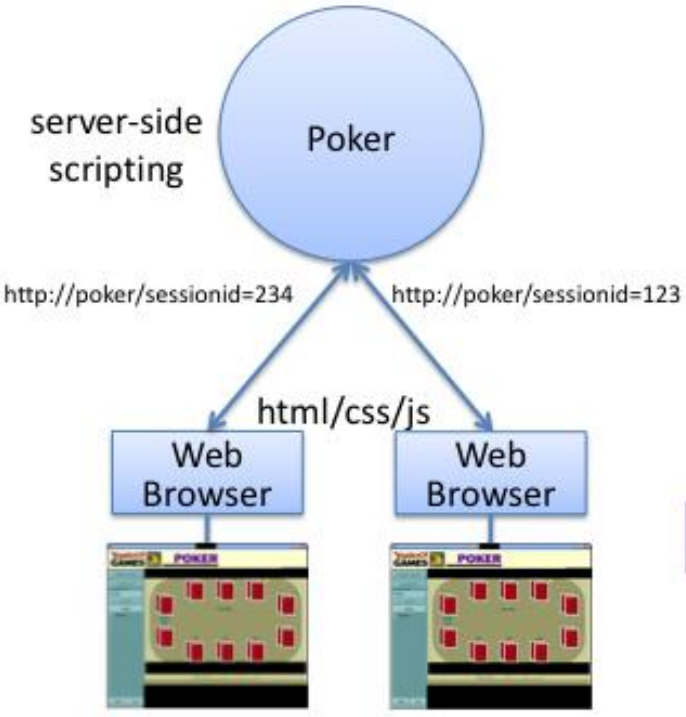
Snap2Pay
One-time use credit cards

Contributions

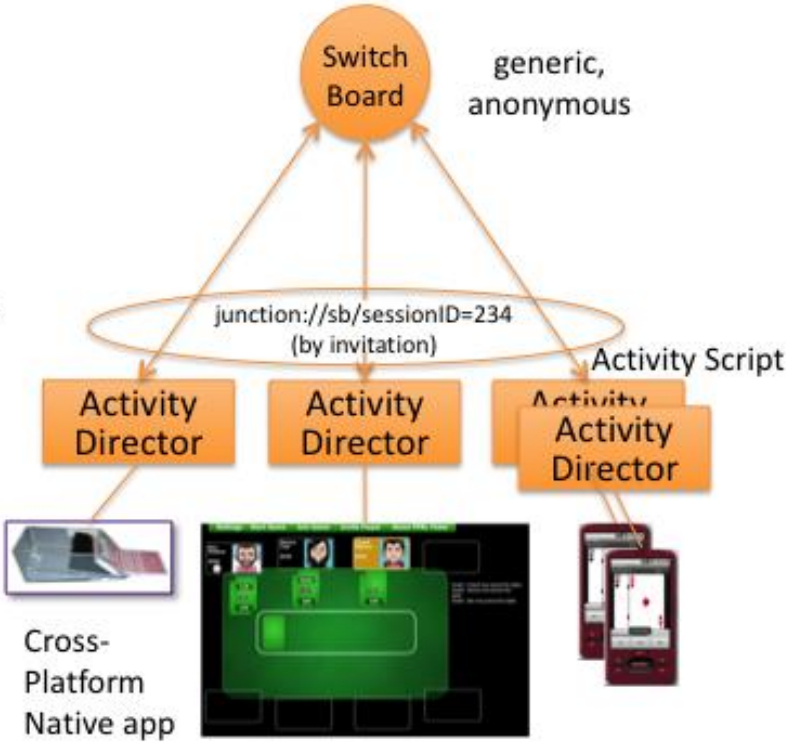
Make developing decentralized, multi-party activities easy.

- Activity Director: Join activities with a single click
  - Junction URIs for easy sharing
- Quick invitations for nearby activities
  - QR codes, Bluetooth beacon
- Cross-platform programming
  - Activity script for resolving platform-specific code
- Switchboard: A universal, app-agnostic messaging service
  - Separate resource provisioning from app development

Architecture



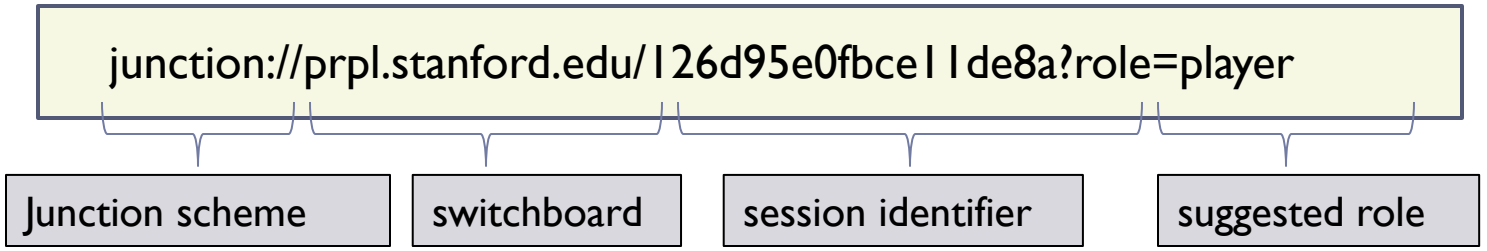
Web application



Junction activity

Sharing Activities

- Activity sessions are represented as URIs
- The URI allows a participant to look up the activity script as well as join the activity.



Activity Script

- Cross-platform programming via an activity script
  - Defines the roles of an activity
    - Also specifies platforms and codebases for each role
  - Defines unique identifier for activity, as well as a friendly name
  - Represented as JSON

weHoldEm's Activity Script

Dealer

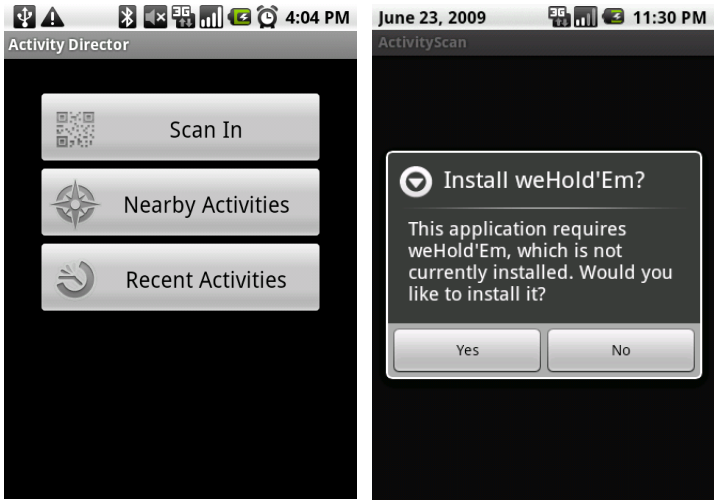
Table

Player

```
{ ad: "edu.stanford.prpl.poker",
   friendlyName: "weHold'Em",
   roles:   { "player": {platforms:
                              {android: {package: "edu.stanford.prpl.poker",
                                                 url: http://prpl.stanford.edu/poker/downloads/poker.apk}},
                              {web: { url: "http://prpl.stanford.edu/poker/play" }}}
              "table":    {platforms:
                              { web: {url: "http://prpl.stanford.edu/poker/table" }}},
              "dealer": {platforms:
                              { java: {url: "http://prpl.stanford.edu/poker/downloads/dealer.jar" }}}}}
```

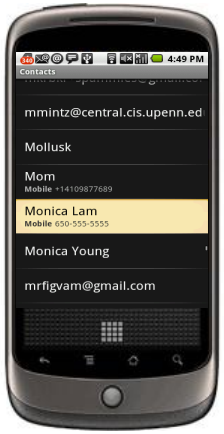
Sharing Activities :: Activity Director

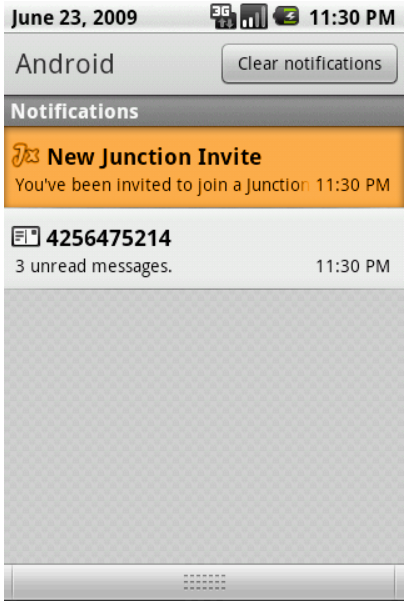
- Director, like a web browser, enables "click-and-run" for activities
  - Handles junction:// URIs in a universal way
  - Active usage: Phone joins nearby activity
  - Passive usage: Push application to settop box



Sharing Activities :: Invitations

- Use the Activity Director to share invitations in useful ways
  - QR Code: Secure, visual channel, supported on different platforms
  - SMS: Invite mobile friends at a distance
  - Email, IM, Blog, etc. (like web links)
  - Activity developers expose sharing to users; Junction library makes this easy.
- Director accepts any invitation and launches the appropriate app





Switchboard and Client Implementation

- Switchboard built on standard, out-of-the-box XMPP
  - Uses Multi-User Chat extension
    - All Junction operations containable in MUC
  - Works on most standard XMPP implementations
  - Use BOSH for HTTP connections
- Three client platforms currently supported
  - Javascript (uses StropheJS XMPP library)
  - Desktop JAVA (uses Smack)
  - Android (JAVA library augmented with platform-specific hooks)
- Fairly easy to add new platforms
  - Many existing XMPP client libraries

Switchboard Service

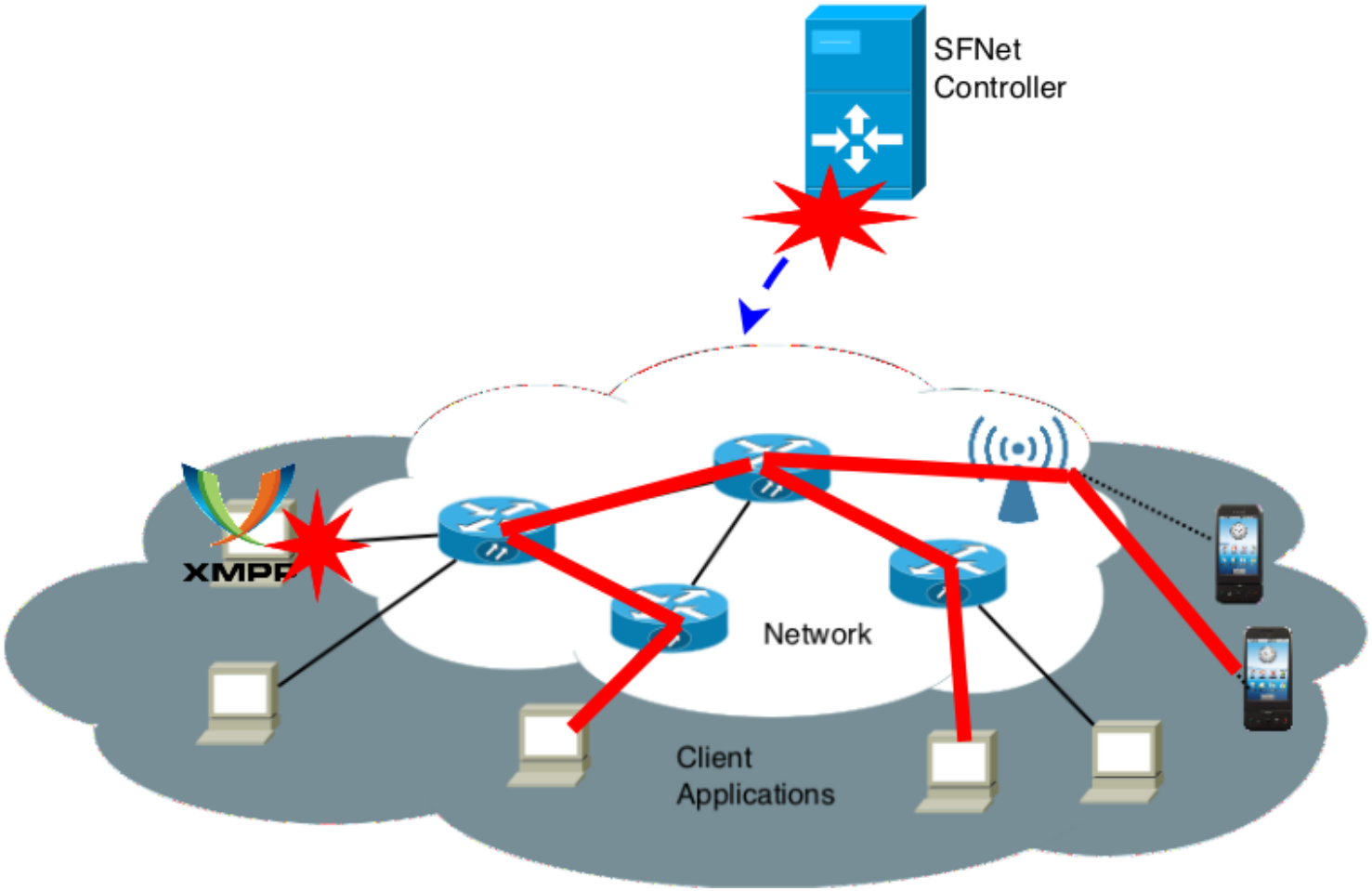
Advantages

- Scalability
- Separation of concerns
- Choice of privacy and economic models
- High-level abstraction enables optimization (OpenFlow)
- Open API

Deployment models

- Application-dedicated
- Personal or institutional
- Peer-to-peer
- Vicinity
- Network operator

SFNet – Multicast Delegation



Junction Applications

Application	Lines of Code Per Role	Dev. Days	Ad Hoc	Platform-spanning	Personal Data
Social apps: Communication					
weMeet	200	1	✓		✓
weClick	Instructor:140, Player: 120	1	✓	✓	
Multimedia: Quick and fun collaboration					
weTube	Player: 450, Phone: 600	1	✓	✓	✓
weTunes	Jukebox: 520, Remote: 420	2	✓	✓	✓
Games: Scalable, distributed applications					
weBluff	1500	3	✓		
weHold'Em	Player:800, table:750, dealer: 1700	30	✓	✓	
Personal apps: use the phone and the PC together					
Snap2Pass	Host: 1600, web: 120, phone: 400	6		✓	✓
Snap2Web	Browser: 320, phone:400	1		✓	✓

Conclusion

- Device-spanning activities
- Ease of use: “Click-and-run” for ad hoc activities
- Ease of development: Multiparty activities
- Ease of deployment: Separate app development from infrastructure concerns with a switchboard

[Appendix]

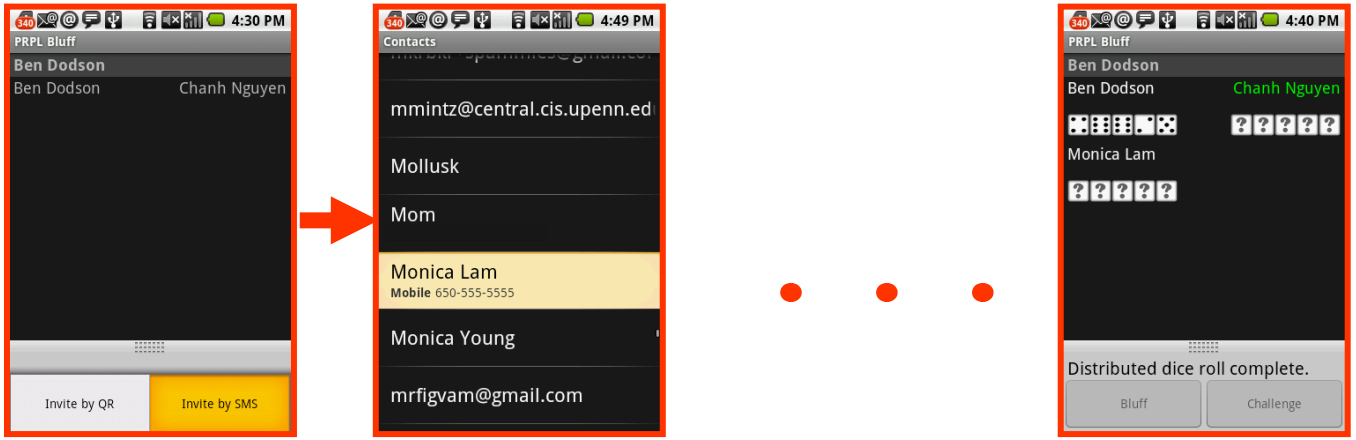
PocketSchool Interactive Learning Adhoc Network

- Story comprehension
- Encourage learning through competition.
- Paul Kim, Sch. of Edu

Sunnyvale School District, Feb 2010

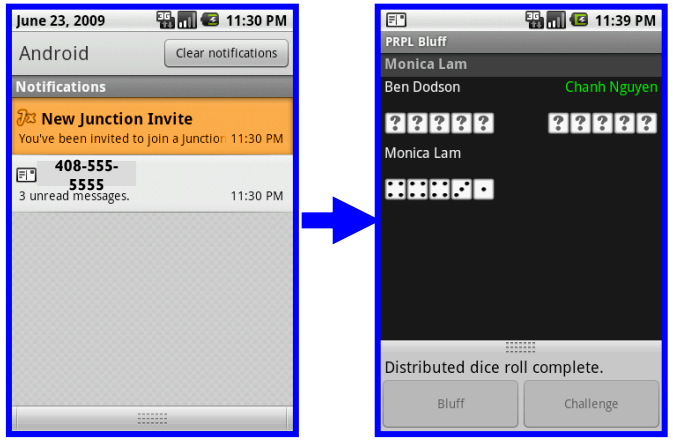
Ad-Hoc Game Between Phones

Start Activity
Invite by SMS



Accept

Download software
Join activity



Hello Junction (Javascript)

```
/*[(  Javascript includes and HTML gui omitted.  )]*/
/* Activity Script */
var spec = /* JSON activity script */;

/* Actor */
var receiver = { roles: [ "receiver" ],
    onMessageReceived:
          function(msg) {
              $('#inbound').append(msg.text);
          }
};

 /* Binding */
var jm = JunctionMaker.getInstance("prpl.stanford.edu");
var jx = jm.newJunction(spec, receiver);

/* Invitation URI */
var invite_qr = jx.getInvitationQR("sender");
$('.invitationQR').attr('src',invite_qr);
```

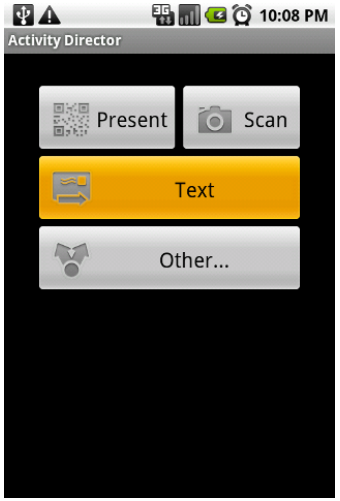
Programming Invitations

- Applications can expose different mechanisms for sharing activities
- Can also utilize the Director for exposing all possible methods supported by the platform

```
// Show a QR code in Javascript
var imgURL = jx.getInvitationQR("player");
$("#qr_img").attr(src,imgURL);

// find an activity by QR in Android
AndroidJunctionMaker
                .getInstance()
                .findActivityByScan(this);

// General-purpose invite in Android
AndroidJunctionMaker
                .getInstance()
                .inviteActor (this,jx,"player");
```



Motivation

- Mobile phones as identity device
  - Store files, bookmarks, shared secrets
  - Stronger privacy than any cloud service
  - Always connected

Sharing Activities :: Casting

- Phones are actively used by users
- Other devices (servers, settop boxes) not as much
- For them, Director passively accepts invitations